NASA Experimental Program to Stimulate Competitive Research
(EPSCoR)
Administered by Office of Education, NASA
Congressionally Directed Appropriation
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PROJECT DESCRIPTION

Public Law 102-588, passed in 1992, authorized NASA to initiate NASA EPSCoR to strengthen the research capability of jurisdictions that have not in the past participated equably in competitive aerospace research activities.

The twenty-eight jurisdictions eligible to participate in FY 2013 are Alabama, Alaska, Arkansas, Delaware, Hawaii, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Dakota, Oklahoma, the Commonwealth of Puerto Rico, Rhode Island, South Carolina, South Dakota, Vermont, West Virginia, US Virgin Islands (Aligned with South Carolina), and Wyoming. An additional jurisdiction, Guam became eligible and because of its size, is aligned with Hawaii. Guam did not submit a 2013 EPSCoR Research proposal.

The goal of NASA EPSCoR is to provide seed funding that will enable jurisdictions to develop an academic research enterprise directed toward long-term, self-sustaining, nationally-competitive capabilities in aerospace and aerospace-related research. This capability will, in turn, contribute to the jurisdiction's economic viability and expand the nation's base for aerospace research and development. Since its inception, NASA EPSCoR has been closely linked to the National Space Grant College and Fellowship Program (Space Grant).

PROJECT GOALS

The specific objectives of NASA EPSCoR are to:

- Contribute to and promote development of a research capability in NASA EPSCoR jurisdictions in areas of strategic importance to the NASA mission;
- Improve the capabilities of the NASA EPSCoR jurisdictions to gain support from sources outside the NASA EPSCoR program;
- Develop partnerships between NASA research assets, academic institutions, and industry;
- Contribute to the overall research infrastructure, science and technology capabilities, higher education, and economic development of the jurisdiction; and
- Work in close coordination with the Space Grant consortium in the jurisdiction to improve the environment for science, technology, engineering and mathematics (STEM) education.

PROJECT BENEFIT TO OUTCOME (1, 2, OR 3)

NASA EPSCoR directly supports Outcome 1, which comprises five Objectives. EPSCoR directly contributes to Objectives 1.1 and 1.5 and may also contribute to Objectives 1.2, 1.3, and 1.4.

- Objective 1.1 – Faculty and Research Support: Provide NASA competency-building education and research opportunities for faculty, researchers, and post-doctoral fellows.
- Objective 1.5 -- Targeted Institution Research and Academic Infrastructure: Improve the ability of targeted institutions to compete for NASA research and development work.

The two main components of NASA EPSCoR are:

- NASA EPSCoR Research Infrastructure Development (RID)
  The RID Cooperative Agreements enable jurisdictions to build and strengthen relationships with NASA researchers. The RID has a three-year base period of performance with a potential single, two-year renewable period of performance. Awards are up to $125,000 per year. A one-to-one cost-sharing (cash or in-kind) is required for every NASA dollar awarded. There is also an additional $25,000 for jurisdictions in their first year of the RID program. EPSCoR completed a 3 year RID award in October 2012. The next NASA EPSCoR RID opportunity will be in 2015, pending funding availability.
- NASA EPSCoR Research Awards
  Research Cooperative Agreements address topic-specific, high-priority NASA research and technology development needs. Awards are up to $750,000 for a three-year performance period. Awards are required to provide cost-sharing, the percentage of which may vary from year to year. NASA intends to announce the EPSCoR CAN for Research Awards yearly, pending funding availability.

Efforts began in 2013 to develop two additional activities:

- International Space Station Flight (ISS) Opportunity
  The NASA Office of Education, in cooperation with the International Space Station (ISS) Research Office, will solicit proposals that utilize the ISS as a microgravity platform or test bed for a spaceflight demonstration. Awards are up to $100,000 for a three-year performance period. NASA intends to announce the EPSCoR ISS Awards yearly, pending funding availability.
- NASA Virtual-to-live Workshops
  The NASA Office of Education, in cooperation with the Space Technology Mission Directorate will conduct a series of virtual workshops targeted toward the EPSCoR jurisdictions. The workshops will initially be conducted utilizing WebEX or Google+ then move to live sessions at various NASA Centers.

PROJECT ACCOMPLISHMENTS THROUGH 2012

2009-2011 Research Award Annual Reporting (Including MSI)

Cooperative Agreements Reporting	66
Faculty/Post-docs Involvement	373
Student Involvement	573
Peer Reviewed Publications Accepted or Published	321
Other Publications Accepted or Published	137
Talks/Presentations at Professional Meetings	597
Patents Applied For (or Pending)	13
Patents Awarded	2
Collaborations with NASA Centers	87
Collaborations Other	279
Technical Transfer Activities	40
Number of new/reviewed STEM courses	62
Number of Additional Grants Awarded	153
Value of Additional Grants	$43,449,000

2007-2012 Research Infrastructure Development Annual Reporting

Cooperative Agreements Reporting	41
Faculty/Post-docs Involvement	436
Student Involvement	320
Peer Reviewed Publications Accepted or Published	96
Other Publications Accepted or Published	42
Talks/Presentations at Professional Meetings	196
Patents Applied For (or Pending)	5
Patents Awarded	1
Collaborations with NASA Centers	136
Collaborations Other	202
Technical Transfer Activities	10
Number of new/reviewed STEM courses	36
Number of Additional Grants Awarded	59
Value of Additional Grants	$9,618,268

2007-2009 Research Award Final Reporting

Cooperative Agreements Reporting	26
Faculty/Post-docs Involvement	214
Student Involvement	375
Peer Reviewed Publications Accepted or Published	201
Other Publications Accepted or Published	88
Talks/Presentations at Professional Meetings	384
Patents Applied For (or Pending)	21
Patents Awarded	8
Collaborations with NASA Centers	72
Collaborations Other	132
Technical Transfer Activities	18
Number of new/reviewed STEM courses	51
Number of Additional Grants Awarded	109
Value of Additional Grants	$47,731,735

2007-2009 Research Infrastructure Development Final Reporting

Cooperative Agreements Reporting	14
Faculty/Post-docs Involvement	558
Student Involvement	911
Peer Reviewed Publications Accepted or Published	382
Other Publications Accepted or Published	170
Talks/Presentations at Professional Meetings	625
Patents Applied For (or Pending)	32
Patents Awarded	2
Collaborations with NASA Centers	268
Collaborations Other	439
Technical Transfer Activities	5
Number of new/reviewed STEM courses	45
Number of Additional Grants Awarded	227
Value of Additional Grants	$113,415,184

PROJECT CONTRIBUTIONS TO PART MEASURES

Among the EPSCoR jurisdictions, partnerships from EPSCoR Research awards include 201 university departments from across the country. Schools benefiting from EPSCoR awards include:

Alabama A&M University
Arkansas State University
Arkansas Tech University
Auburn University
Austin Peay State University
Bigelow Laboratory for Ocean Sciences
Bluegrass Community and Technical College
Boise State University
Boston University
Brigham Young University
Brookhaven National Lab
Brown University
Bryant University
California State University Long Beach
Caltech
Chinese Academy of Sciences
Clafin University
Clemson University
Colby College
Colorado School of Mines
Colorado State University
Dartmouth College
Denmark Technical College
Desert Research Institute
Drake University
East Central University
Flathead Valley Community College
Georgia Institute of Technology
Grambling State University
Harding University
Hawaii Institute of Geophysics and Planetology
Hong Kong University of Science and Technology
Idaho State University
Iowa State University
Iowa State University, Department of Agronomy
Jackson State University
Kansas State University
Kansas State University, Salina
Kauai Community College
Kentucky State University
Lander University
Langston University
Los Alamos National Laboratory
Louisiana State University
Louisiana Tech University
Maine Institute for Human Genetics and Health
Marshall University
Medical University of Graz, Graz, Austria
Miami University
The University of South Carolina
Tohoku University
Tougaloo College
Traction Technologies, LLC
Trevecca Nazarene University
Truckee Meadows Community College
Tufts University, NASA Bioinformatics Ctr
Tulane University
Tuskegee University
University of Massachusetts Lowell
University of Alabama
University of Alabama in Huntsville
University of Alaska Anchorage
University of Alaska Fairbanks
University of Alaska Southeast
University of Arkansas at Fort Smith
University of Arkansas at Pine Bluff
University of Arkansas for Medical Sciences
University of Arkansas, Fayetteville
University of Arkansas, Little Rock
University of Buffalo
University of California - Davis
University of California - Irvine
University of California, Berkley
University of Central Arkansas
University of Central Oklahoma
University of Colorado-Boulder
University of Delaware
University of Hawaii at Hilo
University of Hawaii at Manoa
University of Idaho
University of Idaho, Moscow
University of Illinois
University of Iowa
University of Iowa, Chemical & Biochemical Engineering
University of Iowa, Civil & Environmental Engineering
University of Kansas
University of Kentucky
University of Maine
University of Maine - Orono
University of Memphis
University of Michigan
University of Mississippi
University of Mississippi Medical Center
University of Mississippi, Dept. of Otolaryngology
University of Mississippi, Dept. of Radiology
University of Mississippi, Dept. of Pathology
University of Missouri - Kansas City
University of Missouri, Columbia, MO

Michigan State University
Mississippi College
Mississippi State University
Missouri State University
Missouri University of Science and Technology
Missouri University of Science and Technology
Montana State University
Massachusetts Institute of Technology
Montana State University Billings
Montana Tech
Morehead State University
Murray State University
National University of Ireland - Galway
Navajo Technical College
New Jersey Medical School,
New Mexico Institute of Mining and Technology
New Mexico State University
Nicholls State University
North Dakota State University
Northwest Nazarene University
Northwestern University
Oak Ridge National Laboratory
Oglala Lakota College
Oklahoma State University
Orangeburg Calhoun Technical College
Pacific Northwest National Laboratory
Plymouth State University
Prairie View A&M
Rhode Island School of Design
Rocky Mountain College
Saint Louis University
Saint Michael's College
Salish Kootenai College
Shepherd University
Sinte Gleska University
South Carolina State University
South Dakota School of Mines & Technology
South Dakota State University
Southeastern Oklahoma State University
Southern Arkansas University
Southern University
Southern University and A & M College
Southwestern Oklahoma State University
Stanford University
SUNY Downstate University, Brooklyn, NY
Tennessee State University
The Citadel
The City College of the City University of New York
The College of Charleston
The Medical University of South Carolina
The University of Louisiana at Lafayette
University of Montana
University of Montana, Department of Computer Science
University of Montana, Department of Geoscience
University of Nebraska - Lincoln
University of Nebraska at Kearney
University of Nebraska at Omaha
University of Nebraska Medical Center
University of Nevada, Las Vegas
University of Nevada, Reno
University of New Brunswick
University of New England
University of New Hampshire
University of New Mexico
University of New Orleans
University of North Dakota
University of Northern Iowa, Department of Geography
University of Oklahoma
University of Puerto Rico at Bayamon
University of Puerto Rico at Humacao
University of Puerto Rico at Mayaguez
University of Puerto Rico at Rio Piedras
University of Rhode Island
University of South Alabama
University of South Carolina
University of South Dakota
University of Southern Maine
University of Southern Mississippi
University of Tennessee
University of Texas at El Paso
University of the Virgin Islands
University of Toronto
University of Tulsa
University of Utah
University of Vermont
University of Wyoming
University of Wyoming - Chemical Engineering
University of Wyoming - Chemistry
University of Wyoming - Electrical Engineering
University of Wyoming - Environmental Engineering
University of Wyoming - Geology and Geophysics
University of Wyoming - Mechanical Engineering
University of Wyoming - Physics and Astronomy
University Puerto Rico
Utah State University
Vanderbilt University
Vermont Technical College
Washington University in St. Louis
Weber State University
West Virginia University
West Virginia Wesleyan College
Wichita State University

The table below shows the amount of the awards and the match provided by the jurisdictions in the EPSCoR Programs in FY13. There were 14 Research awards

funded in FY13. The next RID competition will be in FY 2015 and additional projects are being developed.

EPSCoR 2013 Awards and Cost-Share

	Award	**Cost-Share**	**Total**
Research FY13	$10,466,822	$ 6,000,874	$16,467,696
Totals	**$10,466,822**	**$6,000,874**	**$16,467,696**

PROJECT PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

NASA science and engineering personnel are associated with all NASA EPSCoR Research Cooperative Agreements. Each task has a Technical Monitor (TM) who provides guidance and technical advice, reviews annual reports, and provides feedback to the EPSCoR staff. These TM's, most of who are located at NASA Centers, are nominated by the Education Liaison in the appropriate Mission Directorate.

Below are examples of benefits in addition to the accomplishment of the research objectives reported in 2013 (prior research) which also includes 64 Technology Transfer activities and the following number of patents:

Final Reports (closed projects)

UT	NNX09AW08A	3-Sep-13	4 patents
VT	NNX09AO60A	31-Aug-13	1 patent
ME	NNX08AY69G	4-Aug-12	1 patent
WY	NNX07AM19A	31-May-13	1 patent
ID	NNX07AL05A	31-Jul-13	1 patent

Annual Reports:

NV-NNX10AR89A	1 patent pending	AL-NNX10AN26A	1 patent pending
SD-NNX09AU83A	1 patent pending	LA-NNX11AM17A	1 patent pending
NV-NNX07AM20A	1 patent pending		

Alabama – Patent Pending
Researchers at the University of South Alabama announced the discovery of a novel method for producing z-alignednanofiber stitched fiber reinforced polymer (FRP) composites. Dr. Kuang-Ting Hsiao, a Professor of Mechanical Engineering, and Mr. Gregory Hickman, a graduate student in Mechanical Engineering, have been working on this exciting research topic funded by Alabama NASA-EPSCoR Program (grant number NNX10AN26A) and Alabama Space Grant Consortium fellowship (grant number: NNX10AJ80H) for more than two years. Recently, Hsiao and Hickman verified this patent-pending breakthrough in composite material manufacturing via repeatable experimentation. High performance

composites such as carbon fiber reinforced polymer (CFRP) are key materials for aerospace, defense, and space exploration industries due to their lightweight and high strength compared to steel and aluminum alloys. However, lack of sufficient strength in the plastics connecting the carbon fibers makes CFRP vulnerable to failure such as delamination. In response, nanofillers such as carbon nanotubes and carbon nanofibers have been used in CFRP to enhance durability, but improvement is limited due to lack of alignment control and insufficient adhesion between the nanofillers and the polymer matrix. Hsiao and Hickman's experimental results, verified a novel method used to manufacture new high performance FRP composites enhanced with through-thickness aligned (zaligned), high aspect-ratio nanofillers such as carbon nanofibers or long carbon nanotubes. The length of the nanofibers and the stitching pattern further promote the interaction between micro and nano-scale reinforcements in the polymer matrix system through both adhesion and mechanical interlocking between carbon fibers and nanofibers. This new material can be stored in prepreg form and is suitable for emerging Out of Autoclave- Vacuum Bag Only curing processes in conjunction with advanced lay-up techniques such as automatic tape laying and fiber placement. Hsiao's composite materials research group is continuing in the process of rigorous mechanical testing for this new material.

Iowa

Iowa NASA EPSCoR project on new class of polymer matrix composites concludes. Principal investigator is Michael Kessler, Iowa State University associate professor of materials science and engineering. Co-investigators from the materials science and engineering department at ISU, researchers from the mechanical and industrial engineering department at the University of Iowa, seven graduate students, five undergraduate students and two postdoctoral associates from Iowa State and the University of Iowa have also worked on the project over the last three years. The goal of this project, now successfully completed, was to design and evaluate a new class of polymer matrix composites reinforced with high dielectric constant nanoparticles and continuous glass fiber for multifunctional applications such as structural capacitors and damage or deformation sensors. The nanocomposite resins, nano-macro composite hybrids, associated fabrication techniques and modeling efforts that were developed through this research program were designed to meet the following technical objectives: 1) Engineer and optimize, simultaneously, disparate material properties such as structural and electromagnetic properties, 2) Achieve energy storage and structural efficiencies that result in net mass reduction compared with systems with separate energy storage and structural components. Over the last two years, the project has focused on designing, investigating and modeling the multifunctional behavior of candidate materials for the dielectric layer in multifunctional structural capacitors. This involved several different material systems and investigations, including 1) a high-temperature thermoplastic polyimide/barium titanate nanocomposite system, 2) a systematic study of the nanoparticle interphase and its effect on the resulting dielectric behavior of the composite, 3) a thermosetting cyanate ester matrix

system reinforced with Si nanoparticles, and 4) a three-phase cyanate ester system reinforced with silica-coated iron oxide nanoparticles. These systems were evaluated by extensive dielectric, thermal and mechanical characterization techniques, and micromechanical modeling was used to evaluate the effective properties of these multiphase systems.

North Dakota

The University of North Dakota (UND) has developed a concept for colonizing the moon. They have developed the concept, built the hardware and equipment, and are now in habitat testing. Here's what's been tested in multiple locations, including North Dakota, Antarctica, Colorado, Arizona, New Mexico, and Florida:
Housing - A 40-foot long, 10-foot wide and 8-foot high inflatable building with a metal frame will house up to four astronauts for six months at a time. Inside, there are four bedrooms, a kitchen, a bathroom and a laboratory. At one end is a long tube that hooks up with a rover.
Transportation - The moon rover looks like a tiny minivan with two hatches in back for hooking up with the spacesuits. The inside contains air so astronauts don't have to be in the bulky spacesuits while driving around. Aircraft maker Cirrus Design's, Grand Forks factory helped build the fiberglass body.
Clothing - The lunar spacesuit, NDX-2, is designed with the necessary flexibility to walking around on the moon. Today's space suits are meant for use in space where wearers basically just float around. There's a hatch in the back to hook up with the rover.
A key feature of the project is everything hooks up to everything else so an astronaut can walk from the lunar habitat into the lunar rover and then dons a spacesuit without going through an airlock. UND successfully completed a 10 test of the system in collaboration with Ames Research Center. The university is making the system available to researchers across NASA to test their new designs and innovations.

Louisiana

MARSLIFE Modes of Adaptation, Resistance, and Survival for Life Inhabiting a Freeze-dried-radiation-bathed Environment is the subject of research by a group of researchers and students to include the LSU Biology Dept, LSU Physics Dept, Louisiana Tech University, Southern University, Aarhus University and NASA – Ames. The presence of water on Mars and on a number of planetary moons (e.g., Europa, Enceladus, Ariel, and Triton) suggests that multiple loci within the solar system may plausibly support microbial life. In this context, the overarching theme of the MARSLIFE project is that selective pressures in terrestrial extreme environments serve as "training grounds" that enrich for microbial phenotypes that may dominate extraterrestrial habitats on Mars and elsewhere. The MARSLIFE program is: (1) investigating existing and novel microorganisms with tolerances to cold, desiccation, and radiation as models for astrobiology; (2) using laboratory simulators to assess responses of selected extremophiles to temperature, pressure, and radiation conditions that exist in a range of extraterrestrial environments; (3) characterizing biological resistance mechanisms to freezing, desiccation, and radiation, and (4) improving

technologies for the detection and sampling of microorganisms under conditions similar to the surface of Mars. The outcomes include the development of fundamental astrobiological concepts and operational capabilities that will promote the success of future NASA-driven life detection missions, inform policies on planetary protection, and lay the foundation for a new space research enterprise in Louisiana. The project builds upon stimulus work supported by Space Grant and EPSCoR and utilizes the expertise already developed through student ballooning projects. The institutions, LSU, SU and LaTech, bring together a variety of research and education capabilities and, in conjunction with NASA mentors, the relationships nurtured within MARSLIFE are producing technologically informed, interdisciplinary scientists, fostering new technology and educational opportunities, and increasing the collaboration between NASA and Louisiana.

Idaho – Patented

The present application relates generally to the field of ionizing radiation dosimeters and more specifically to radiation dosimeters that comprise a chalcogenide glass layer configured to interact with metal atoms. A radiation dosimeter is an instrument for measuring the dose of radiation absorbed by a matter or the intensity of a source of radiation, usually measured over a period of time. Dosimeters are used in proximity to nuclear power sources, such as sea- or land-based nuclear reactors, in proximity to reactive elements in labs or in proximity to nuclear waste, and used by astronauts, among other things. One of the more prevalent types of radiation dosimeters are film badge dosimeters. Film badge dosimeters are usually made of two parts: a reactive or photographic film and a film holder. The film is removable and may be developed in order to measure exposure. The film is sensitive to radiation and once developed, the areas of the film that have been exposed to radiation exhibit an increased optical density. Additionally, a badge may contain several films of different sensitivities or a single film with multiple coatings, in order to measure a wider range of exposure levels than in the single film/single coating implementation. However, film badge dosimeters have several disadvantages. Perhaps the most significant disadvantage is that they are not useful as a clear real-time indicator of radiation exposure. There is a need for an ionizing radiation sensor configured to provide real-time results. There is also a need for a reversible ionizing radiation sensor. To address these needs the Idaho researchers invented and patented a chalcogenide glass radiation sensor comprised of a chalcogenide glass radiation sensing module coupled to a measurement module and a display module. The chalcogenide glass radiation sensing module includes a chalcogenide glass layer having a resistivity and coupled to at least two electrodes and a metal source. The at least two electrodes are configured to facilitate the measurement of the resistivity of the chalcogenide glass layer, and the coupling of the chalcogenide glass layer and the metal source is such that the resistivity of the chalcogenide glass layer changes upon exposure to ionizing radiation. The metal source is also positioned external to an electric field that may form between the at least two electrodes as the resistivity of the chalcogenide glass layer is measured. The measurement module is configured to measure the resistivity of the chalcogenide

glass layer, and the display module is configured to display a measured resistivity.

Louisiana – Patents Pending
Dr. Guoqiang Li and Dr. Gefu Ji have filed for patents on their EPSCoR project titled "Bio-mimetic Self-Healing Composite Sandwich for Impact Tolerant NextGen Aerospace Structures". A new shape memory polymer (SMP) based syntactic foam has been fabricated and its thermo-mechanical behavior under 2-D stress condition has been investigated. Crack sensing ability by embedded carbon nanotube network has been demonstrated. A new 'theoretical' model, involving damage and useful in implementing applications, has been developed and disseminated. While the team is still in the process of obtaining all the equipment for manufacturing SMP fibers, the self-healing ability of lab scale SMP fiber reinforced polymer beam has been proved. A NASA visit has been made. Education activities are progressing smoothly with several participating students received their Ph.D., M.S., and B.S. degrees. The team was also recognized by LSU and Southern University as evidenced by a number of faculty and student awards received. The team submitted or published two dozen papers in archival journals and has submitted two provisional patents. Overall, the project is a huge success and is meeting its research and education benchmarks.